

WHAT IS CLAIMED IS:

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1. A semiconductor device, comprising:

a semiconductor substrate having a first surface and a second surface opposite the first surface, and having a piercing hole piercing there-
10 through from the first surface to the second surface;

an insulating film formed on the first surface of the semiconductor substrate having the piercing hole extended there-through; and

15 a piercing electrode formed in the piercing hole and extending from the insulating film to the second surface,

wherein the piercing hole has a first diameter in the insulating film and a second
20 diameter in the semiconductor substrate which is wider than the first diameter;

the piercing electrode has a substantially same diameter as the first diameter along a whole length thereof; and

25 an insulating film sleeve lies between the piercing electrode and an inside wall of the piercing hole in the semiconductor substrate.

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2. The semiconductor device as claimed in claim 1, wherein the insulating film sleeve is made of an organosiloxane group material, a siloxane
35 hydroxide group material, an organic polymer, or a porous material of the organosiloxane group material, the siloxane hydroxide group material, or the

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organic polymer.

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3. The semiconductor device as claimed in claim 1, wherein the insulating film sleeve has a relative permeability of approximately 3.0 and under.

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4. The semiconductor device as claimed in claim 1, wherein the piercing electrode is made of a metal whose main component is a copper.

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5. A semiconductor integrated circuit device, comprising:

a support substrate; and

a plurality of semiconductor chips stacked on the support substrate;

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the semiconductor chip including a semiconductor substrate; a semiconductor element formed on a first surface of the semiconductor chip; an insulating film formed on the first surface of the semiconductor chip as covering the semiconductor element; a multi-layer interconnection structure formed on the insulating film; a piercing hole formed in the semiconductor chip as piercing from the first surface into the insulating film through a second surface facing to the first surface; and a piercing electrode formed in the piercing hole and extending from the first surface to the second surface; wherein the piercing hole has a first

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diameter in the insulating film and a second diameter in the semiconductor chip which is bigger than the first diameter; the piercing electrode has a substantially same diameter as the first diameter
5 along whole length; and an insulating film sleeve lies between the piercing electrode and an inside wall of the piercing hole in the semiconductor substrate.

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6. The semiconductor integrated circuit device as claimed in claim 5, wherein the insulating
15 film sleeve is made of an organosiloxane group material, a siloxane hydroxide group material, an organic polymer, or a porous material of the organosiloxane group material, the siloxane hydroxide group material, or the organic polymer.

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7. The semiconductor integrated circuit device as claimed in claim 5, wherein the insulating
25 film sleeve has a relative permeability of approximately 3.0 and under.

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8. The semiconductor integrated circuit device as claimed in claim 5, wherein the piercing
electrode is made of a metal whose main component is
35 a copper.

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9. A method of manufacturing a semiconductor device having a piercing electrode, comprising:

- 5 a step of forming an insulating film on a first main surface of a semiconductor substrate;
- a step of forming an opening which exposes the semiconductor substrate and has a first diameter, in the insulating film;
- 10 a step of forming a concave which has a second diameter wider than the first diameter in the semiconductor substrate and extends from the opening into the semiconductor substrate, by anisotropic etching which acts in a direction substantially perpendicular to the main surface of the
- 15 semiconductor substrate and which utilizes the insulating film as a mask;
- a step of filling the opening and the concave with an application insulating film;
- a step of forming a space that
- 20 continuously extends from the opening to a depth into the application insulating film filling the concave, by anisotropic etching which etches the application insulating film on a direction
- 25 substantially perpendicular to the main surface of the semiconductor substrate and which utilizes the insulating film as a mask;
- a step of stacking a conductive layer on the insulating film as filling the opening and the space;
- 30 a step of forming a conductive plug in the opening and the space by removing the conductive layer from the insulating film; and
- a step of exposing the conductive plug by a process of removing what covers the conductive
- 35 plug and what stacks on a second main surface of the semiconductor substrate which is opposite to the first main surface from the second main surface.

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10. The method of manufacturing a semiconductor device as claimed in claim 9 wherein the application insulating film is made of an organosiloxane group material, a siloxane hydroxide group material, an organic polymer, or a porous material of the organosiloxane group material, the siloxane hydroxide group material, or the organic polymer.

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11. The method of manufacturing a semiconductor device as claimed in claim 9 wherein the application insulating film has a relative permeability of approximately 3.0 and under.

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12. The method of manufacturing a semiconductor device as claimed in claim 9 wherein the process of removing the construction material regarding the semiconductor substrate from the second main surface of the semiconductor substrate comprises a dry etching process, and the application insulating film is made of a material which is tolerant to the dry etching process.

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13. The method of manufacturing a semiconductor device as claimed in claim 12 wherein the dry etching process is a process of exposing the conductive plug from the second main surface of the semiconductor substrate in a state where the

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